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# Flooding the Vote: Hurricane Katrina and Voter Participation in New Orleans

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## Abstract

To what extent did the extensive flooding caused by Hurricane Katrina affect voter participation in the 2006 mayoral election? This article uses voting record data from 20 election cycles, GIS-coded flood-depth data, and census data to examine the voting behavior of registered voters in New Orleans before and after Hurricane Katrina. We use a variety of statistical techniques, primarily propensity score matching methods, to examine how flooding affected mayoral turnout. We find that flooding decreased participation, but registered voters who experienced more than 6 ft of flooding were more likely to participate in the election than those who experienced less flooding. This finding confirms that increasing the cost of voting decreases turnout and suggests several mechanisms motivating an expressive component of voting behavior. Our results indicate there is a complex relationship between participation and the costs and benefits of turnout. Our findings about the characteristics of the voters who participated in the mayoral election provide insights into the scope of change for the political landscape of New Orleans.

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**Introduction**

On August 29, 2005, Hurricane Katrina, then a Category 3 storm, made land-fall near Buras, Louisiana. The storm produced significant rainfall in the Gulf Coast region, which, combined with strong winds and severe storm surges, caused multiple failures to the Lake Pontchartrain flood protection system.<sup>1</sup> These failures flooded approximately 80% of the city of New Orleans. According to the RAND Corporation, the population of New Orleans went from 485,000 before Hurricane Katrina to 155,000 in 2006; the “homes of about 55 percent of the city’s population—268,000 people—suffered severe damage after parts of New Orleans were inundated by floodwaters more than 4 ft deep when the hurricane hit and levees were breeched” (McCarthy et al., 2006).<sup>2</sup>

Katrina hit New Orleans shortly before the city was to conduct a regularly scheduled mayoral election. Incumbent Mayor Ray Nagin, who had first been elected in 2002, became internationally known in the aftermath of Katrina due to his frequent television appearances and some uneasiness about his handling of the post-Katrina situation. The first round of the 2006 New Orleans mayoral election (held April 22, 2006) was a contest between 22 candidates and, as no candidate received a majority of votes cast, a runoff election was scheduled to take place on May 20, 2006.<sup>3</sup> Mayoral incumbent Ray Nagin won 38% of the vote in April and 52% of the vote in May, resulting in his final victory. His campaign emphasized the potential racial demographic change in the city, with Nagin, an African American, claiming that New Orleans should be a “chocolate city” (Whoriskey, 2006). Nagin’s primary opponent in the runoff election, Democrat Mitch Landrieu, was White. As stated by New Orleans City Council President Oliver M. Thomas Jr., “There is a strong sense in the black community that some in the white community are trying to pile it on” and predicted that “anger will motivate many displaced voters to cast ballots, even if it means taking long bus trips back” (Whoriskey, 2006). This highly racialized campaign for mayor focused not only on who would be responsible for rebuilding the city but also on the race of that elected individual.

The realization that the mayor’s office would be directly responsible to Black voter policy concerns, particularly those who had suffered severe flooding, had the potential to generate increased Black empowerment, and consequentially increased participation (Bobo & Gilliam, 1990). The election results

were heavily determined by race. Although Nagin received 85% of the White vote in his 2002 campaign, in the runoff mayoral election in 2006 he received less than 10% of the White vote (Konigsmark, 2006).

That this potentially transformative mayoral election occurred in concert with the devastation of Hurricane Katrina provides a critical test of standard theories about the costs and benefits of electoral participation. The traditional calculus of voting indicates that when the costs of participation increase, voters should be less likely to turnout. Katrina dramatically increased the cost of voting, so fewer voters would be expected to turnout. However, with collective anger about flood damage, high media coverage, voter mobilization campaigns, and some frustration about the local government response to the disaster, the benefits of participation for many may have increased substantially. The stakes in this mayoral election were high, as this election could determine the path of the rebuilding process in New Orleans. Despite the potential difficulty of participating in this election for those voters most affected by flooding, the expressive benefits of participation in this election were particularly relevant to those same voters who had firsthand experienced Katrina's devastation. These voters had collectively experienced a governmental failure, and those most affected realized the potential consequences of ignoring their civic responsibilities.

In this article, we test three hypotheses, based on three competing theories that we discuss in detail below that can explain electoral participation in the 2006 mayoral election. The first hypothesis is that those voters who experienced heavy flooding would be less likely to vote. Theories of the cost of voting suggest that voters who bear the heaviest costs associated with voting—those voters who were subject to the high levels of flood damage—should be least likely to vote. These voters were more likely to be displaced, with many having to live outside New Orleans, and therefore they might be required to take extraordinary steps to vote. Second, based on research about which individuals are likely to vote, we anticipate that there will be interactions between flood depth and individual characteristics (e.g., low socioeconomic status) such that some groups of individuals will have a particularly difficult time voting when the turnout cost increases. Specifically, we predict that the flood most affected voters who have historically had a more difficult time casting a vote. Our normative concern is that the flooding of Hurricane Katrina could change the population of potential voters, affecting both the election and the quality of representation during the Katrina recovery.

Third, we consider whether administrative or motivational theories of voting may have worked to counteract the cost of voting dilemma noted above. Specifically, from an administrative standpoint, efforts were made to make

voting more accessible and convenient, as early voting, absentee voting, and vote centers, were used. These purely administrative benefits were targeted toward the displaced voter, although all voters could use most of these reforms. We therefore would expect that these administrative effects would serve to mitigate some of the cost of voting effects. Finally, consistent with the literature on motivation, we hypothesize that, although flooding does decrease turnout, it does not necessarily do so in a consistent fashion; and in particular, those voters who experienced the worst flooding may in fact be the most likely voters. This hypothesis is consistent with other research which has found that residents deeply affected by natural disasters become more civic-minded after the event (Tatsuki, 2007, 2008). This hypothesis is also consistent with the highly racialized campaigning which emphasized the race of the future mayor.

We test these hypotheses with 20 years of voter history data from New Orleans. We integrate this individual-level voting data with Census block economic and social variables and information regarding the highest level of flooding. This is the first study of its kind on post-Katrina participation to use individual level data. In addition, we apply propensity score matching, which allows us to make inferences about the effect of flood depth on participation without making strong assumptions about the functional relationship between flooding and participation. If turnout in the New Orleans mayoral race was purely an issue of the costs of voting, we would expect, *ceteris paribus*, that voters in flooded areas would vote at lower rates than do voters in relatively unflooded areas. However, if there were strong administrative and/or motivational factors working in the election, then we would expect that turnout might actually be higher in areas that had been flooded than would otherwise be the case. We find that flooding does decrease turnout, but contrary to our expectations, there are no statistically significant interactions between voter characteristics and flood depth. Thus although voting is to some extent depressed in the post-Katrina era, there is some reason for optimism: we do not find that the effect of flooding is worse for particular groups. Most interestingly, for those with the highest levels of flooding, they appear to have been mobilized to participate. This effect is also nonlinear. Our findings here reinforce previous literature that finds motivation to be a powerful factor driving political participation.

## **The Mayoral Election and Expressive Political Participation**

Classic rational choice models conceptualize the costs and benefits of voting in a linear equation, where equal weight is given to costs and benefits (Aldrich,

1995; Downs, 1957). The Downsian model assumes that costs have both a linear relationship to participation and are exogenous to the benefits. In this article, we challenge both of these assertions. The extensive flooding caused by Hurricane Katrina allows us to take a close look at the costs and benefits of participation. The flooding from Hurricane Katrina allows us to examine an exogenous shock—an increase in costs of voting—where those costs are unevenly distributed across voters. Yet we posit that disasters like Katrina can increase both costs and benefits. First, we suggest that for voters who experienced flooding as a consequence of the hurricane, their costs of voting would increase. Second, we suggest that these voters may also have increased motivation to participate in the political process, both from an increase in recruitment and from an increase in their desire to express their political preferences. We find support for both hypotheses but with the available data cannot distinguish whether this is driven by an increase in expressive preferences or an increase in recruitment. In addition, in our analysis, we challenge the linear functional form of the traditional models of participation.

Hurricane Katrina raised dual concerns about the increased cost to voter participation in the mayoral election. Costs are defined with the potential difficulty of casting a ballot. One concern was that the displacement of voters itself would have a direct and negative affect on voters most affected by the flooding. Specifically, Katrina might impose a high cost of voting on those directly displaced by the flooding because they would not necessarily have easy access to polling places or voting materials on election day. The second concern was that the complex array of procedures that were put in place to make voting easier for displaced voters might, contrary to their intentions, raise the costs and reduce the participation of the very individuals these procedures were designed to assist.<sup>4</sup>

These concerns mesh well with theoretical models of voter participation. Seminal theoretical work by Downs (1957) and Riker and Ordeshook (1968) presented the notion that when it is more costly for an individual to participate in an election, *ceteris paribus*, the less likely it is for that individual to participate. This basic theoretical notion has been tested by many scholars, beginning with Wolfinger and Rosenstone (1980). Many later studies (e.g., Leighley & Nagler, 1992; Nagler, 1991; Oliver & Wolfinger, 1990) have shown that complex procedures can hinder the participation of many voters, especially those who many not have the resources necessary to overcome these hurdles imposed by these procedures.

The flooding and displacement caused by Katrina clearly increased the cost of voting for many individuals who had lived there prior to the flooding event. Although we cannot directly quantify these costs, we can compare

these costs to those in a typical election. For example, research has found that moving a polling place 1 mile in a normal election can reduce turnout by 1.5%, and that precinct consolidation generally results in reduced turnout (Brady & McNulty, 2002; Dyck & Gimpel, 2005; Gimpel & Schuknecht, 2003; Haspel & Knotts, 2005). Moreover, efforts to make voting more convenient typically do not increase turnout but instead merely make participation easier for medium- to high-propensity voters (Berinsky, 2005; Flower, 2006). In the 2006 mayoral elections, there was both a consolidation of precincts (many previously-used polling places were destroyed by the flood) and an expansion of convenience voting methods (early, absentee, and quasisivote centers).<sup>5</sup> However, we should not expect, based on traditional research, for these improvements to increase turnout.

Although the flooding caused by Katrina might have imposed a significant fixed cost on those who wanted to vote in the mayoral election, it is also the case that those who faced the most extensive flooding might have been highly motivated to vote.<sup>6</sup> Here, we posit that voters are affected by recruitment and increased motivation.

As Gerber and Green (2000) have noted, personal mobilization can play a critical role in improving turnout. In a multimode experiment, they found that face-to-face contacts can increase turnout by almost 10%. Although we have no data on efforts to mobilize Katrina victims—either those who were displaced or those who were able to remain in New Orleans—media accounts tell us that all three contact modes mentioned above were employed. For example, The Metropolitan Organization in Houston conducted a face-to-face campaign to sign up 10,000 absentee voters (Moreno, 2006) and the Association of Community Organizations for Reform Now (ACORN) conducted organizing campaigns in several cities, including Texas and Georgia, and provided bus transportation to allow voters to vote in person in Louisiana for the election. ACORN hired canvassers to go door-to-door in apartment complexes with high numbers of displaced voters, with the intention of registering them to vote, getting them absentee ballots, and/or offering them rides to the polls (Hotline, 2006).<sup>7</sup> The candidates also engaged in mobilization efforts; for example, incumbent mayor Ray Nagin campaigned in several surrounding states to rally voters and his campaign also conducted face-to-face campaigning in states neighboring Louisiana.

The Louisiana Secretary of State, Al Ater, noted that the catastrophe should be considered a motivational experience for voters, encouraging them to participate in the election and in the subsequent rebuilding of the city. Ater stated, “If this whole crisis, this whole disaster doesn’t motivate people, I don’t think we’re ever going to get them motivated, are we?” (Moreno,

2006). One displaced voter echoed this, saying “[voting] is the start of getting my life back” (Simpson, 2006). Another displaced voter who had driven nearly 8 hours to be able to cast a ballot issued a similar sentiment, saying, “This determines the future of our city” (Nossiter, 2006). Voters had reasons to be motivated to participate in the election that would determine who would lead the rebuilding of their city. This motivation to participate in this important mayoral election can be seen in national surveys as well as surveys conducted only of Louisiana residents. A survey of Louisiana resident adults by the Pew Center for People and the Press found that “just 34% give state and local governments an excellent or good rating on their handling of the disaster, down from 41% last week. Public evaluations of the federal government’s response [were] 37% positive, 61% negative.”<sup>8</sup> At the national level, there were concerns about the quality of the response to Katrina just 2 weeks after the disaster.

A state-level survey conducted by Louisiana State University also illustrates how important the election was for residents of New Orleans.<sup>9</sup> In this survey, the data show that the state government and New Orleans city government ranked last in a list of 12 organizations—including the federal government and FEMA—in evaluations of effectiveness in hurricane response. In addition, respondents were aware that the post-Katrina period would continue to be one where government would be tested, through choices regarding budget cuts, rebuilding efforts, and service provision. Respondents also were personally affected and were likely motivated by that as well. For example, more than half of respondents felt depressed (53%), 41% were unable to work and lost income, and 39% felt angry because of the storms. Other scholars have documented the ability of voters to associate blame and responsibility with elected officials in light of the Katrina disaster, and the additional emotions surrounding the devastation may also increase the desire of citizens to participate (Malhotra & Kuo, 2008, 2009).

Verba, Scholzman, and Brady (1995) have documented that resources such as time, money, and civic skills are critical determinants of whether an individual can easily navigate the world of politics. Individuals well endowed with resources are more engaged and interested in politics, and they have connections to others that mobilize them to participate. Congruent with this observation is the hypothesis that individuals who belong to particular groups tend to behave similarly—and many of those individuals who participate in politics do so because someone they knew asked them to participate. Similarity of behavior within a social framework has been studied in many settings, ranging from urban ghettos to homeowners (Cutler & Glaeser, 1997). Although there may have been a decline in social capital among American



voters (Putnam, 1993, 1995), the relationship of individuals to particular groups is a good predictor of individual behavior (Coleman, 1990). Finally, and relatedly, there is recent research that argues that political participation may be habitual (Plutzer, 2002).

In this disaster, the residents of New Orleans collectively experienced a failure of government. After Katrina, possibly more than ever before, they were faced with the realization that their livelihoods, homes, and neighborhoods were linked not only to the performance of the local government but also to whether others in New Orleans were participating in the political process and holding local government accountable for rebuilding their city. Nowhere was this potentially more true than among African American voters, who have long cast ballots based on perception of a linked fate—the extent to which an individual sees his or her fate (social, economic, political) as related to the fate of the larger group (Dawson, 2001). This is a population in which linked fate has been documented, where some voters substitute group interest for self-interest. Could the African American voters of New Orleans, particularly those in the most heavily damaged areas, do the same? As non-Whites made up a very large segment of New Orleans' electorate (66% of registered voters were non-White), this is a potentially significant phenomenon. Looking at the raw data, we note that for both White and non-White voters who experienced more than 5 ft of flooding, they are slightly more likely to cast a ballot in the May 2006 mayoral contest.<sup>10</sup> This suggests that the flooding of Katrina generated a collective identity: a feeling of group consciousness whereby individuals who experienced the worst devastation realized that they had the agency to cast a ballot to rebuild after Katrina. Chong and Rogers (2005) maintain that collective identity is derived both from identification of group membership as well as a conscious belief about the actions necessary to enact political change. They refer to this as the generation of solidarity. They state, "Solidarity consists of group identification as well as interpretive and prescriptive group-based ideologies transmitted through elite messages, contact among group members, and exposure to a common culture or history" (p. 369).

We thus test theories that posit that Katrina gave New Orleans voters a strong motivation to vote. This increased motivation could arise from many sources: some might have desired to hold local elected officials, particularly the mayor, accountable for their handling of the Katrina crisis (Abney & Hill, 1966); some might have been motivated by a sense of linked fate or as the result of mobilization campaigns; others might have been motivated because of other issues, like candidate race or other issues. We hypothesize that increased flooding will increase the desire of voters to express their preferences, even

though increased flooding also makes voting more costly. In some ways, the simple descriptive data provide support for the idea that despite the massive dislocation Katrina induced, New Orleans voters figured out how to participate in the mayoral elections in 2006. In 2002, during Nagin's first run for mayor, 45.7% of registered voters participated in the mayoral primary (February 2, 2002), and 44.3% participated in the mayoral general election (March 2, 2002); in 2006, the turnout percentages were 36.8% and 38.5%, respectively.<sup>11</sup> Certainly, turnout was lower in the 2006 mayoral elections than in the same type of elections in 2002, but the reduction in turnout is not necessarily as dramatic as one might anticipate given Katrina's damage.

This hypothesis—that turnout will increase with motivation—is consistent with literature on the expressive act of casting a ballot. Scholars suggest that voters will be more likely to vote when the civic duty term is larger than the cost of voting if, for example, voting increases the likelihood of the preservation of a democracy (Blais, 2000; Downs, 1957; Riker & Ordeshook, 1968). Voters may also receive psychological benefit from voting (Brennan & Buchanan, 1984; Fiorina, 1976; Schuessler, 2000). Voting may be a consumption good as voters seek to express themselves despite high costs of voting (Hinich, 1981; Silver, Anderson, & Abrahamson, 1984). This motivation may come from a particular experience, for example, Blattman (2008) finds that child conscription in Uganda results in a 22% increased likelihood of voting as an adult. We hypothesize that voters who are particularly affected by flood depth will have additional motivation to turn out to vote, perhaps because of perceived community needs or to punish perceived bad performance.

Given the commentary that surrounded the election and its aftermath regarding the stability of representation in the city (would Mayor Ray Nagin, who is African American, be reelected?) and whether the real or potential voting population would change because the voters are themselves different (such as fewer Democrats or African Americans in the voting population), these questions are highly relevant to understanding the impact of a highly disruptive natural disaster on a city's politics.

## Data

We obtained from the Louisiana Secretary of State's Office a voter file data set, including individual data on all registered voters in the New Orleans parish, which includes 238,627 individuals. This file incorporates data from all 17 wards, some of which, like the Lower 9th Ward are now, post-Katrina, well known; the file also includes wards that experienced no flooding whatsoever. As noted in the appendix, the voter file was augmented using Census

blockgroup information from Census Summary Files 1 and 3. The variance in the extent of flooding, combined with the wealth of information observed both in the voter history file, and data observed at the Census block level, will allow us to evaluate the extent to which flooding caused by Katrina influenced voter behavior in New Orleans' recent mayoral election.

From this voter file, we observe, for each registered voter, the last 20 elections they participated and when they registered.<sup>12</sup> From these two variables, we produce a "propensity to vote" variable that is calculated as a percentage of the elections in which the individual participated divided by the number of eligible elections. This variable is intended to capture the frequency with which an individual in our data set participates in elections prior to Katrina. In our data set, the average voter propensity is 39.45% (with a standard deviation of 25%) and this variable takes values which range from 0% to 100%. This is the variable that we use to measure the effect of Katrina's flooding on habitual voters. We focus our attention on the runoff mayoral election (held May 20, 2006) which had a higher turnout rate (113,591 compared with 108,153) and had received a larger amount of publicity. The later election date also allowed each voter additional time to determine how to cast a ballot in the Katrina aftermath.<sup>13</sup> We also observe a number of characteristics about each individual; their age, their race, their voting history, and their party registration. We integrate some Census data at the blockgroup level; incorporation of the number of occupied housing units and median household income allows us to control for variation in the costs of the flooding that could be attributable to the quality of the housing units in each blockgroup.

Each registrant's address is recorded in the voter file, which we used to spatially locate each voter using ESRI's Streetmap© geocodable roads. This was done using a standard GIS procedure called geocoding that provides latitude and longitude for each address. Out of a possible 295,277 records, a total of 238,627 were kept in the data set—these were both successfully matched to their appropriate addresses and had no missing covariates in the registration file.<sup>14</sup> Using data from the United States Geological Survey (USGS), we overlay each address with the approximate depth of the flood water post-Hurricane Katrina. Although the general geography of New Orleans is at or below sea level, the actual extent of flooding varied across the city, based on this geography and where the breaches to the levees occurred. Studies have indicated that large sections of New Orleans were flooded by more than 6 ft of water, and parts of Lakeview, Gentilly, New Orleans East, and the Lower Ninth Ward were flooded with more than 10 feet of water (American Society of Civil Engineers, Hurricane Katrina External Review Panel, 2007, p. 32, Figure 5.10).<sup>15</sup> Almost a third of the voters had residences which were unaffected by Katrina flooding. The category of flooding with the highest number of affected voters is 5 feet of flooding.<sup>16</sup>

These data provide a unique opportunity to analyze turnout behavior in the wake of Hurricane Katrina. In particular, almost all of our variables are individual level data, including the depth of the floodwater and the individual characteristics of each registrant. Much of the analysis thus far on Hurricane Katrina has dealt with aggregate data on turnout, race, and district-level characteristics (Aldrich & Crook, 2008; Davis & Bali, 2008; Logan, 2006); this presents a problem commonly referred to as the *ecological inference* problem, where individual-level inferences are made using aggregate-level data. It has long been known in the social science research literature that individual-level inferences drawn from aggregate-level data are suspect, unless special care is taken to try to alleviate known biases in such ecological inferences (or the researcher uses individual-level data to make individual-level inferences, as we do).<sup>17</sup> The prior findings differ from our own for this reason—here we are able to draw valid individual-level inferences with individual-level data and to find consistent patterns of results with a varied set of statistical techniques.

## Flooding and Turnout

We compare registered voter households with flooding to registered voter households who had no flooding in order to determine the effect of Katrina on turnout in the May 2006 mayoral election. The turnout pattern by flood depth in May is similar to the pattern we observe in the April 2006 election as well. In Figure 1, we present the percentage turnout by flood depth (in feet) for each registered voter household in our data set. When we compare Katrina's flooding to turnout in both elections, we see a very counterintuitive pattern. Had the extent of flooding presented a uniform barrier to voter participation, we should see a negative relationship between flooding and turnout: turnout should be high in areas with little or no flooding and turnout should fall as the flooding increased. We anticipate this pattern because we know that, with enough flood water, residents were forced to leave New Orleans. More than half of New Orleans' residents had not yet returned at the time of the primary election.<sup>18</sup> Instead, we see in Figure 1 something like a curvilinear relationship: high voter turnout in locations with little or no flooding, but equally high voter turnout in locations with the most extensive flooding. This conclusion, reached simply by examining the bivariate relationship between turnout and flooding, is one we will later examine in more detail in our multivariate analysis. After the flooding, 47.31% of those who experience water depth of 9 feet or greater were able to participate—almost 3 percentage points greater than their average participation percentage (as seen in the last column of appendix Table A2). Although the historical propensity to vote is not homogeneous across flood depths, it is the case that there is much

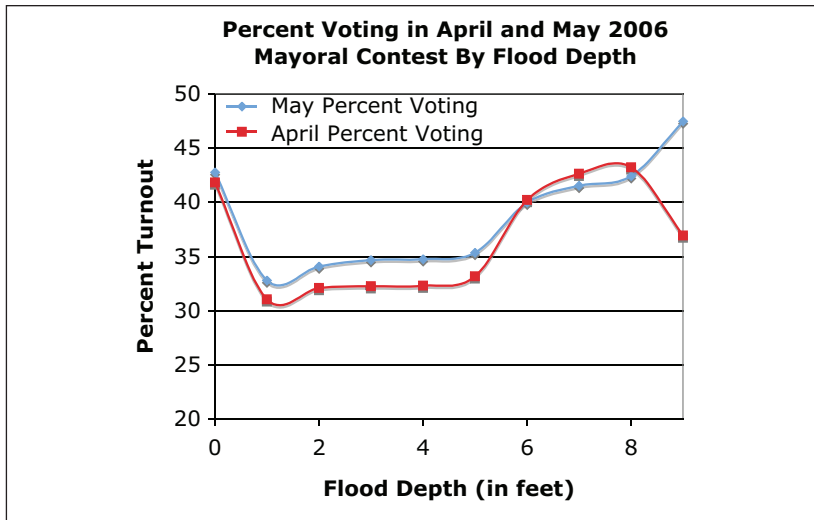


Figure 1. April and May 2006 mayoral turnout by flood depth

less variance (37%-44%) across flood depths in previous vote propensity than there is in the mayoral contest (35%-47%) and that the curvilinear pattern is less pronounced.

## Method and Results

Based on Figure 1, we recognize that a simple statistical analysis of the bivariate relationship between Katrina-induced flooding and turnout in the mayoral election is insufficient as there may not be a linear relationship between flooding and turnout. We thus test for the appropriate functional form: in four statistical models, we successively relax the assumptions about the relationship between the depth of the flood water and a particular functional form to investigate the effect of flood depth on turnout in the 2006 mayoral contest in New Orleans. In Table 1, consistent with our observation that the relationship between flood depth and turnout reported earlier does not appear to be linear, we find that, although flood depth does increase the cost of turning out to vote, the effect of the depth of flooding is not linear and additive.

We begin with a simple analysis to analyze likely voters in a classic turnout model; we first model turnout in the mayoral campaign as a function of an individual's characteristics, including the depth of the flood water post-Katrina. Thus the model is

**Table 1.** New Orleans Flood Depth by Registered Voter

Depth (in feet)	Number of individuals affected	May 2006 turnout	May percentage turnout	Mean propensity to vote
0	89,431	38,258	42.78	40.01
1	23,751	7,788	32.79	36.78
2	34,158	11,640	34.08	38.25
3	25,138	8,715	34.67	38.78
4	25,437	8,842	34.76	39.01
5	16,243	5,740	35.34	39.16
6	7,823	3,128	39.98	42.06
7	8,060	3,348	41.54	42.89
8	7,005	2,972	42.43	43.42
9 (or more)	1,581	748	47.31	44.15
Total	238,627	91,179	38.21	

$$\text{Mayoral vote} = \alpha + \beta_1 \times X + \varepsilon$$

where  $X$  is a matrix of voter characteristics that include flood depth after Katrina, gender, race, age, party registration, and propensity to vote and  $\varepsilon$  is distributed logistically.<sup>19</sup>

We present the coefficients for each of the variables in the second column of Table 2. We find that the coefficient on the flood depth is negative, as anticipated. As the amount of flooding increased, the probability that individuals could turnout for the mayoral contest should decrease, in large part because many of those residents were displaced by the flooding which increased the costs of voting. Many organizations orchestrated bus trips to New Orleans so that voters could cast mayoral ballots and a bus ride from Texas to New Orleans, for example, dramatically increases the cost of voting. We find that the coefficient for gender is not statistically significant, as is the coefficient for non-Whites. Surprisingly, age is negative and statistically significant but effectively zero (the coefficient value is  $-.001$ ).<sup>20</sup>

The variables that affect turnout—other than flood depth—are Democratic registration and propensity to vote. The coefficient on Democratic party registration is positive, which is surprising as many of the neighborhoods which experienced the worst flooding were majority Democratic. However, as the two main candidates in the runoff election were both Democrats (Ray Nagin and Mitch Landrieu), it is also possible that Democratic voters were more interested in the election. The coefficient on propensity to

vote is large and positive, which we would expect. The relationship between propensity to vote and turnout is extremely strong, but there is little correlation between propensity to vote and flood depth (correlation coefficient is .024).<sup>21</sup> From this table, we conclude that in fact the depth of flooding decreases the probability that an individual casts a ballot in the mayoral election.<sup>22</sup> Our next analysis will investigate whether any of these particular covariates interact with the depth of flooding.

Our second analysis incorporates both the interactions between the water depth and the voter demographics as well as a series of community characteristics. Thus our new model is

$$\text{Mayoral vote} = \alpha + \beta_1 \times X + \beta_2 \times Z + \beta_3 \times W + \varepsilon$$

where  $X$  is the same matrix as described above,  $Z$  is a matrix of some of the variables in  $X$  interacted with the flood depth, and  $W$  is a matrix of community-based characteristics, measured at the blockgroup level that includes the education level of the blockgroup, the median income of the blockgroup, and information on the type of housing (percentage renter occupied) for the blockgroup. We assume  $\varepsilon$  is logistically distributed. We include these variables as control variables and use them as proxies for the individual data.

We hypothesize that voters who are non-White, Democratic, younger and are residents of blockgroups with less education, more renters, and lower median incomes will be more affected by flood damage. It seems unlikely that the additional costs associated with postflood voting would be evenly distributed across groups. We present the coefficients from this model in the first column of Table 2.<sup>23</sup>

Only one coefficient for the interaction is statistically significant—the interaction between flood depth and Democratic registration. Our hypotheses about the effects of interactions are not supported here—in particular, the marginal effect of flooding for Democratic registrants is positive. For an additional 1 foot of flooding, the odds of a Democratic registrant voting decrease less than for any other party registrant. Our other coefficients are sensible and consistent with the hypothesis that increased flooding decreased turnout.<sup>24</sup>

In both columns, we find that the flooding depressed turnout. If we calculate the first differences from the coefficients on flood depth from the second column, we find that a change in flood depth from 3 to 8 feet, for example, would decrease the probability of voting by almost 4 percentage points. A change in flood depth from 0 to 9 feet, would decrease the probability that an individual voted by more than 7 percentage points.<sup>25</sup> However, as the effects of flooding may not be linear and additive, we are cautious about these results.<sup>26</sup> This

**Table 2.** Logistic Coefficients, Dependent Variable Vote for Mayor 2006

Variable	Coefficient Model 1	Coefficient Model 2
Flood depth	-0.043* (.01)	-0.037* (.002)
Female	-0.001 (.010)	-0.001 (.010)
Non-White	-0.009 (.016)	-0.013 (.010)
Democratic registration	0.001 (.014)	0.036* (.011)
Propensity to vote	5.72* (.035)	5.30* (.025)
Age	-0.001 (.000)	-0.001* (.000)
Flood depth × Non-White	0.000 (.004)	
Flood depth × Propensity to vote	-0.195* (.011)	
Flood depth × Democratic registration	0.015* (.004)	
Flood depth × Age	0.000 (.000)	
Percentage in blockgroup with a high school degree	-0.000 (.074)	
Percentage of residents in blockgroup Black	0.012 (.023)	
Percentage in blockgroup of renter-occupied housing units	0.004 (.031)	
Median household income in blockgroup	0.000 (.000)	
Constant	-2.87* (.048)	-2.66* (.022)
N	238,627	238,627
Pseudo R <sup>2</sup>	.21	.21

\* $p = .10$ . \*\* $p = .05$ .

seems likely given the difficulty in understanding the coefficients presented in Table 2 in the context of the traditional voter turnout literature. It is likely that particular neighborhoods were affected disproportionately by the flood—one component of this may simply be in the targeting, post-Katrina, of different categories of social services. We are cautious in using these results as we understand that we are effectively treating an ordinal variable as though it were continuous. Given this concern, we turn to a different technique.

To better analyze the effects of the flood variable, we apply a method for determining appropriate cutpoints for the effect of flooding on mayoral vote (Walter, Feinstein, & Wells, 1987). First, we produce an indicator variable  $X_K$  for each  $K$  feet of flooding, where  $X_K = 0$  if the flood depth is below  $K$  and 1 if the flood depth is equal to or above  $K$ . We incorporate each of these variables ( $X_1$  through  $X_9$ ) such that the model is



**Table 3.** Logistic Coefficients With Ordinal Flood Cutpoints, Dependent Variable Vote for Mayor May 2006

Variable	Coefficient
Flood depth 1-2	-0.40* (.02)
Flood depth 2-6	0.01 (.02)
Flood depth 6	0.15* (.03)
Flood depth 7-9	0.06** (.03)
Flood depth 9 or more	0.24* (.06)
Female	0.00 (.01)
Non-White	-0.01 (.01)
Democratic registration	0.09* (.01)
Propensity to vote	5.29* (.03)
Age	-0.001* (.0003)
Constant	-2.56* (.02)
N	238,627
Pseudo R <sup>2</sup>	.21

\*\*p = .05.

$$\text{Mayoral vote} = \alpha + \beta_1 \times X_1 + \beta_2 \times X_2 + \dots + \beta_k \times X_k + \beta_{k+1} \times W + \varepsilon$$

where  $W$  is a matrix of voter characteristics that include gender, race, age, propensity to vote, and party registration, and each of the  $X_K$ s are included with  $X_0$  used as a base case and  $\varepsilon$  is distributed logistically.

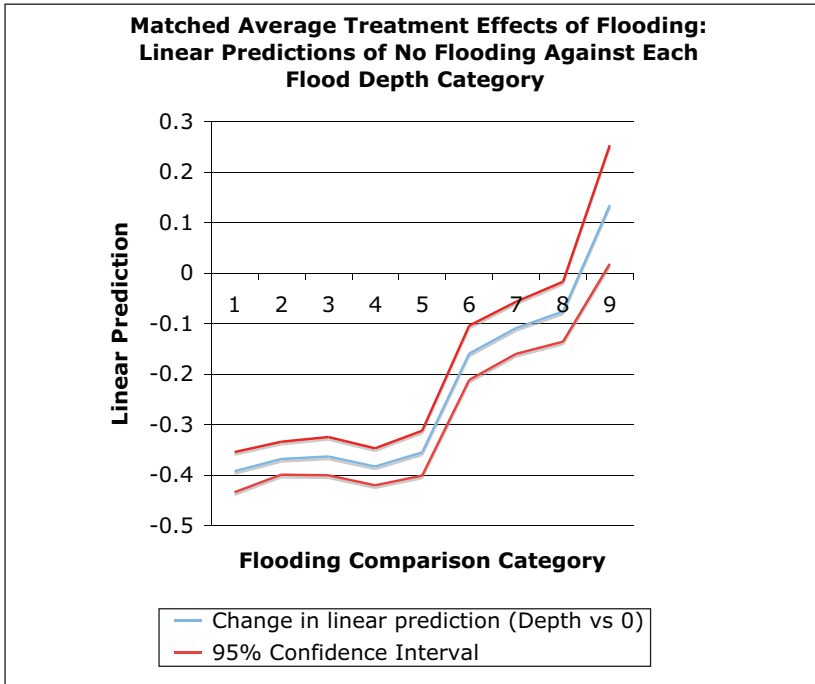
We then analyze the results from this regression, in particular focusing on the coefficients from each of the  $X_K$ s. The interpretation of each of the coefficients for each of the  $X_K$ s is as follows: the coefficient evaluates the relative impact of flooding between values  $k$  and  $k + 1$  compared with no flooding. For each  $X_K$  that has a coefficient which is itself statistically significant, we determine that there is a true cutpoint at each of those values, so that in fact the probability that an individual votes in the mayoral election is affected by flooding between the two  $X_K$ s with significant coefficients. After our analysis, we find that there are five  $X_K$  values which qualify: these are flood depths of 1, 2, 6, 7, and 9. We repeat the above model incorporating only those  $X_K$  values. These results are presented in Table 3.

With this method, we see that there are jumps in treatment effects because we are no longer constrained to incorporate the flood variable as both linear and additive. The coefficients for the  $X_K$  variables range from positive to negative, implying that particular groups are often more affected by flooding than others. We observe a negative coefficient for flooding from 1 to 2 feet, but positive and statistically coefficients from 3 or more feet. The range in

coefficients appears initially quite unintuitive, but in fact it is simply likely that the flood increased the cost of voting for individuals in some categories but not in others. Although it is surprising is that there is such a positive and statistically significant effect of flooding depth on turnout for flood depth of 6 feet or more, it is possible that these individuals were simply more likely to turnout already—that, for example, their propensity to vote indicated they were likely voters. These results indicate that the effect of flood depth on turnout is not constant. As we present the results from our final statistical technique, we anticipate finding a nonlinear and in particular nonmonotonic result from the coefficients we observe in Table 3.

We now turn to a final statistical technique which relaxes assumptions about the functional form, as we have found that a linear functional form was not appropriate. Therefore, to ensure that our results are not a consequence of modeling assumptions, we use propensity score matching, considering as the treatment the number of feet of flooding each voter experienced from Katrina. We let  $t_i$  indicate that registered voter  $i$  has been exposed to treatment  $t_i$ , where  $t_i$  takes on each value from 0 to 9 in terms of depth of flooding. That is, we first match individuals who had no flooding to those who had 1 foot of flooding, and we then follow by matching those who had no flooding to those who had 2 feet of flooding. We continue for each flood depth. We observe the mayoral turnout,  $y_i$  for each  $i$ , and, in addition, a series of covariates  $X_i$ , where  $X_i$  includes all individual-level covariates. Matching is necessary because  $t_i$  and  $X_i$  are not independent; for example, it seems likely that in areas with higher median household income, there would be less flooding. We preprocess our data to eliminate the relationship between  $t_i$  and  $X_i$ : To do this, we must locate individuals across different flood depth values who have identical covariates and perform our analysis on these individuals only.<sup>27</sup> Analysis of these individuals will return results similar to those from a randomized experiment and, to a large extent, there is little relationship already between the different treatment groups as the flooding from Hurricane Katrina struck without regard to many of the covariates included in our models.

We begin by isolating individuals across different flood depth values with similar characteristics (matching), and we assess the quality of this comparison with a technique referred to as *balance*, where we compare the distributions of the covariates by flood depth to assess their similarity. We do so by using the statistical software MatchIt (2004) and employing subclassification matching (Ho, Imai, King, & Stuart, 2004).<sup>28</sup> This process is designed to match observations when there are many covariates to consider for the treatment and control groups. The goal is to form subclasses where the distribution of the covariate values is identical for the treatment and control groups as opposed the exact



**Figure 2.** Matched ATE

values of the covariates. After pulling out a subset of observations, we then assess the quality of the match by looking at the percentage of observations that are balanced before and after the match as well as presenting quantile-quantile-plots for each covariate for each treatment pair.<sup>29</sup> We present these results in the appendix, where we present results regarding match quality in terms of the percentage improvement for each covariate for each treatment pair.<sup>30</sup> We observe a decrease in balance in two instances: for 5 feet of flooding, the percentage in the blockgroup who are high school graduates increases in terms of distance between 0 and 5 feet, and for 9 feet of flooding, there is a decrease in balance for the individuals who are registered as Democratic.<sup>31</sup>

In this analysis, we consider the treatment effect comparing zero flooding to flooding in each of the categories. Each individual flood effect is plotted as a comparison against the base category (no flooding) in Figure 2, where we consider the change in the linear prediction. We observe an upward-trending curve for effects when setting all other covariates at their mean. The red bars

**Table 4.** Average Treatment Effect: Probabilities of Voting in May 2006 Mayoral Contest, Matched Sample

Water depth comparison	Change in probability of voting
Pr(Vote—1 ft) – Pr(Vote—0 ft)	-.087
Pr(Vote—2 ft) – Pr(Vote—0 ft)	-.083
Pr(Vote—3 ft) – Pr(Vote—0 ft)	-.082
Pr(Vote—4 ft) – Pr(Vote—0 ft)	-.086
Pr(Vote—5 ft) – Pr(Vote—0 ft)	-.081
Pr(Vote—6 ft) – Pr(Vote—0 ft)	-.037
Pr(Vote—7 ft) – Pr(Vote—0 ft)	-.026
Pr(Vote—8 ft) – Pr(Vote—0 ft)	-.018
Pr(Vote—9 ft) – Pr(Vote—0 ft)	.0321

Note: Female, non-White, age, Democratic registration, propensity to vote, percentage high school graduate, median household income, and percentage renter occupied are held constant at their mean values.

around the effect of each flood depth in Figure 2 indicate the 95% confidence intervals. Overall, there is a decrease in the probability of voting with flooding, but as seen in this figure, as the flooding increases, the probability that those voters who were exposed to the greatest amount of flooding are able to cast ballots in the mayoral contest actually increases relative to those who experienced less flooding. To interpret the magnitude of this effect, we present the mean effects for each flood category against the base case using a matched sample in Table 4. The largest effects on turnout of the flooding were among those individuals who experienced only 1 foot of flooding; they were 8.7 percentage points less likely to cast a ballot. We compare this quantity with those who experienced, for example, 6 feet of flooding. These individuals were only 3.7 percentage points less likely to cast a ballot.

Our results indicate that flooding decreased the probability of voting on average. However, these results also show that voters who experienced high levels of flooding were more likely to get to the polls than those with lower levels of flooding. Most important, considering the claims of potential racial bias that holding the election would cause, controlling for race and other matched characteristics, voters that experienced the highest levels of flooding were more likely to turn out than the baseline population (no flooding). Referring back to Table 2, note that there is no statistically significant relationship between the interaction of race and flood depth on the probability of turning out to vote. We observe a heterogeneous effect of water depth on the probability of casting a ballot in the mayoral contest, and this effect follows

a upward-shaped pattern. We hypothesize that this pattern could be consistent with the efforts of a variety of voter mobilization campaigns designed to assist those voters who were most affected by the flooding in casting a ballot in conjunction with increased motivation from these particular individuals to participate.

## Conclusion

This article presents an optimistic story about mayoral voting after Hurricane Katrina. Voters whom the media portrayed as having likely higher costs of casting ballots are not necessarily so affected. Although flooding does decrease the probability that an individual casts a ballot, the relationship between flooding and race, partisan registration, and age are not key determinants of the likelihood that an individual casts a ballot. Furthermore, the depth of flooding does not have a constant effect on the probability that an individual casts a vote. That is, within areas of New Orleans that experienced significant flooding, worse flooding has a clear positive association with turnout. Also, heavier flooding is not associated, as might have been expected, with larger negative effects on citizens with fewer personal resources. Both of these findings are counterintuitive.<sup>32</sup>

By using appropriate modeling techniques, we show that the effects of flooding on turnout is not linear. Individuals who live in areas that had large-scale flooding were actually more likely to vote in 2006 than others who suffered less flooding. This suggests that, even though the costs associated with coping with the effects of the flooding for these voters was high, the direct costs of voting were lowered to the point that some of these individuals could vote in the election. Given the high level of interest in the election among interest groups, the candidates, and the media and the introduction of new voting procedures to minimize the costs of voting, such as vote centers, expanded absentee voting, and expanded early voting, both the informational costs of voting and transactional cost of voting were likely reduced. On the informational dimension, the media, interest groups, the candidates, and election officials in Louisiana all worked to reach out to displaced voters. The election reforms introduced reduced the transactional costs of voting. Likewise, the polarized racial dimension also may have increased the benefits of voting for low-income, African American voters as well. African American voters in New Orleans appear to be voting in ways consistent with a perception of linked fates. It seems possible that with severe flooding, New Orleans voters may generally have been likely to respond collectively and to be motivated to participate in local races following Katrina. A disaster such

as Katrina has the potential to generate a multiracial-linked fate, particularly among those voters whose homes were severely flooded and realized that their ballot gave them an opportunity to voice their opinion about the reconstruction of New Orleans.

The pattern of these effects is consistent with two theoretical mechanisms—an increased motivation to participate in municipal politics as well as heightened voter mobilization efforts in the wake of Katrina. We hope that future work can better differentiate whether those who were highly likely to participate, despite extensive flooding, had a high propensity to vote because they were motivated or because they were targeted with convenience voting methods (or both). Our primary contribution to the theoretical literature on voter turnout is to demonstrate that not only are there important comparative statics with respect to the standard cost of voting model that relate to the benefit term but also do these comparative statics suggest that shifts in benefits may be endogenous to shifts in cost. The presence of an inflection point at 6 foot of flooding suggests that this is where the benefits of casting a ballot outweighed the cost. Benefits may be delivered via the increased saliency of the election, the reduction in administrative hurdles due to the procedures put in place immediately following the hurricane, or effective strategies used by mobilization campaigns. The presence of the benefit effect, however, provides evidence that many of the tactics invoked after Katrina were efficacious and that voters can overcome relative resource disadvantages to turnout even in the face of natural disaster.

These findings distinguish this essay from much of the popular journalism on the impact of Katrina on the election. Rather than preventing those voters who had lost so much from participating, the individuals who had experienced the worst flooding were in fact able to turnout and vote. The key difference between our analysis and others is that we use both individual data and a variety of statistical methods to draw our conclusions—the existing work has used aggregate data and fallen prey to the ecological inference problems. Thus our findings also emphasize the need for methodological rigor in drawing social science inferences. This article also presents a rare opportunity to study those individuals who were still directly tied to the New Orleans political process, as the voter lists were purged in 2007/2008 of individuals who had not been able to return to the city (DeCoursey, 2008; Shuler, 2007). That is, this is a study of the participation of voters who experienced the devastation of Hurricane Katrina and not a study based only on those voters who returned to New Orleans. These data provide an opportunity to understand the reactions of those voters who felt politically tied to this particular mayoral election. Owing to the availability of remote polling places,

some of the voters who cast a ballot in this election may never have returned to New Orleans.

Our findings suggest that in the aftermath of the Katrina disaster, it was possible to hold elections that were not biased against resource-limited voters. This normative finding should be comforting to those who were concerned that holding the election so close to the flooding disaster in New Orleans would systematically discriminate against the poor and minority voters. As the *New York Times* reported,

something as simple as sending a mailing to people in a district . . . has become a logistical thicket. Many of the address lists vanished when computers were submerged and, even if they could be found, the addresses were often meaningless. (Levy, 2005)

Arguments regarding when the election would be held were largely driven by the views that people had on what the impact of the diaspora would be on the voting population in New Orleans (Associated Press, 2005). Through effective efforts to lower the cost of voting, and potentially an increase in perceived benefits of participating, the 2006 mayoral election allowed all voters, including those most affected by the flood, to participate and shape the future recovery.<sup>33</sup> Although the population of New Orleans may have significantly changed in the years following Katrina, in this immediate mayoral election after the disaster, many individuals in New Orleans were able to voice their political preferences.

## Appendix

Using the registered voters' addresses in the voter file, it is possible to overlay U.S. Census information. Specifically, we used Census blockgroup information from the U.S. Census Summary Files 1 and 3. The census block data includes the number of housing units of rented in the census block, the median household income in the census block, and the number of residents in the census block who are high school graduates. Census blocks are geographically compact areas which generally contain between 600 and 3,000 people, with an optimum size of 1,500 people. These data allows us to control for community effects which are likely to affect turnout. In particular, the specific inclusion of the number of housing units rented, and the median household income are likely to be key variables in terms of understanding the heterogeneous effect of flooding, as the depth of the floodwater is likely to have a differential effect based on housing prices, which are highly correlated with these variables (Masozera, Bailey, & Kerchner, 2007).

In Table A1, we present a summary of all covariates which we include in our analysis. These variables derive from the voter file, the USGS flood data, and the U.S. Census. Table A2 provides descriptive information on flooding levels.

**Table A1.** Summary of Variables

Variable	<i>M</i>	<i>SD</i>	Min	Max
Female	.56	.50	0	1
Non-White	.66	.47	0	1
Democratic registration	.67	.47	0	1
Propensity to vote	.39	.25	0	1
Age	46.37	17.93	18	100
Percentage (blockgroup) high school degree	.24	.09	.02	.54
Percentage (blockgroup) renter-occupied housing	.52	.24	.02	1
Median (blockgroup) household income	32,306	20,496	10,000	126,071

**Table A2.** Voters With High Flooding by Race and Zipcode

Zipcode	Total voters	Percentage of voters with 5+ ft flooding	Percentage of voters with 5+ ft who are non-White
70112	2,772	10.17	76.24
70113	6,220	10.88	93.50
70114	15,602	10.33	77.17
70115	24,926	10.01	48.44
70116	10,000	9.76	63.63
70117	30,970	10.25	89.51
70118	25,123	10.32	53.28
70119	25,614	10.65	73.71
70122	29,925	10.31	78.35
70124	16,055	10.31	6.94
70125	14,742	9.92	73.94
70126	16,187	9.79	93.25
70130	9,836	10.07	40.81
70131	10,411	10.81	40.18
70148	241	11.62	46.43
70170	3	0	0
<i>N</i>	238,627		

Note: Table indicates that all but zipcodes experienced similar amounts of heavy flooding and a significant percentage of those who experienced more than 5 ft of flooding are non-White. Across New Orleans, 66% of all registered voters are non-White.



**Table A3.** Covariate Means: Unmatched Samples

Flood depth (in feet)	0	1	2	3	4	5	6	7	8	9
Female	.56	.57	.57	.57	.56	.57	.57	.55	.56	.56
Non-White	.65	.66	.67	.67	.67	.66	.66	.65	.66	.65
Democratic registration	.59	.69	.73	.77	.75	.75	.67	.64	.62	.58
Propensity to vote	.40	.37	.38	.39	.39	.39	.42	.43	.43	.44
Age	46.48	46.30	46.31	46.33	46.41	46.22	46.23	46.51	46.19	45.91
Percentage high school graduate (blockgroup)	.232	.234	.233	.233	.233	.232	.233	.232	.232	.233
Percentage renter occupied (blockgroup)	.519	.525	.521	.521	.524	.524	.516	.519	.524	.522
Median household income (blockgroup)	32,432	32,006	32,110	32,050	31,962	32,095	32,387	32,341	31,860	32,101

We assess the differences in covariates by flood depth for the data before we pull out the matched sample. We look at the means of each covariate by flood depth. Table A3 presents these values for each of the covariates of interest by flood depth. Although there are differences which are apparent across flood depths, these differences are not large and are easily correctable via matching.<sup>34</sup> In particular, we note that individuals who experienced more flooding were slightly more likely to have participated in previous elections. This emphasizes the need to include these variables as control variables. That patterns exist with respect to flood depth, and previous turnout has little bearing on these findings after analyzing the matched sample as the matching process will allow us to eliminate preexisting differences across depth categories.

**Table A4.** Quality of Match: Percentage Improvement

Variable	Depth, 1 ft vs.								
	0 ft	2 ft	3 ft	4 ft	5 ft	6 ft	7 ft	8 ft	9 ft
Female	64.80	75.08	63.18	71.06	81.15	71.79	36.38	75.20	31.51
Non-White	76.02	88.48	63.30	60.47	71.11	84.75	85.99	81.48	30.05
Age	81.99	82.26	62.26	54.38	68.15	79.51	50.17	68.69	44.01
Democratic registration	98.31	94.96	90.26	90.42	90.11	99.25	84.00	98.93	-65.53
Propensity to vote	84.03	93.77	72.76	58.28	56.13	99.83	78.31	95.11	96.56
Percentage high school graduate	73.86	87.75	55.88	51.94	-135.13	75.23	82.15	73.73	73.30
Median house- hold income	69.52	87.28	62.27	60.09	64.13	49.72	59.10	84.21	58.84
Percentage rent occupied	74.25	84.71	40.95	70.24	71.07	47.92	30.91	82.65	52.52

In addition, we provide one set of QQ plots to describe our balanced data. Here, we present only one set of such plots, the remainder of which are available from the authors. In the Figures A1 through A4 below, there is little visible improvement to the data set (these observations compare no flooding with 1 foot of flooding). However, in both cases, the balance is fairly close—most of the observations surround the 45° line—and given that this is the case, we have confidence in these estimates.

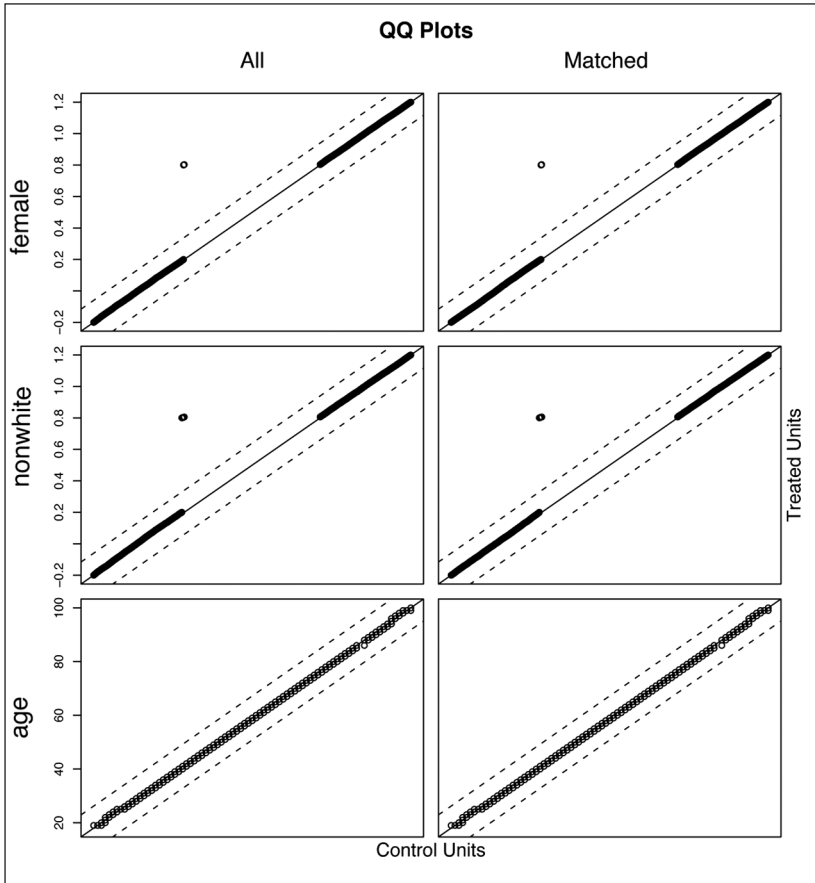


Figure A1. QQ plots, matched versus unmatched sample

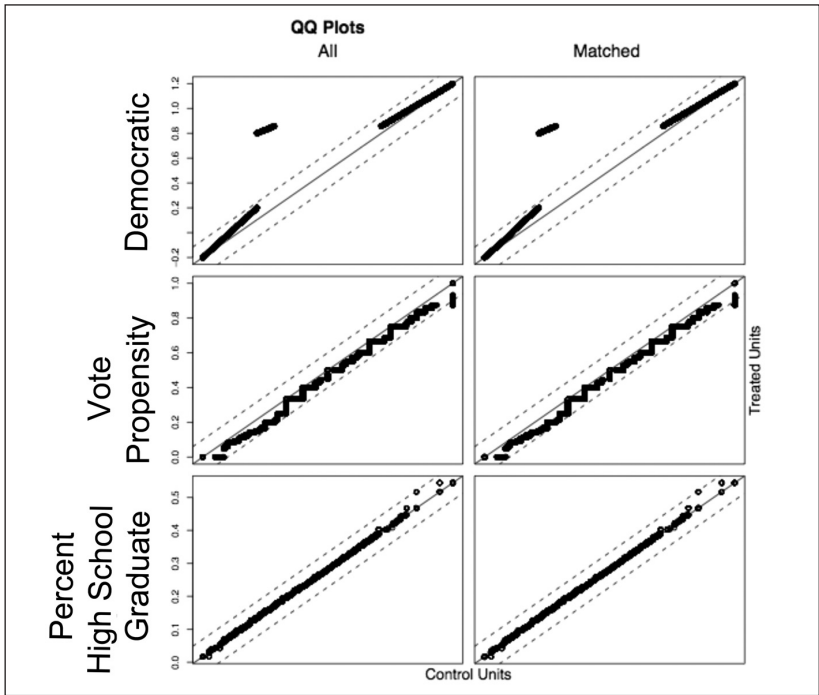


Figure A2. QQ plots, matched versus unmatched sample

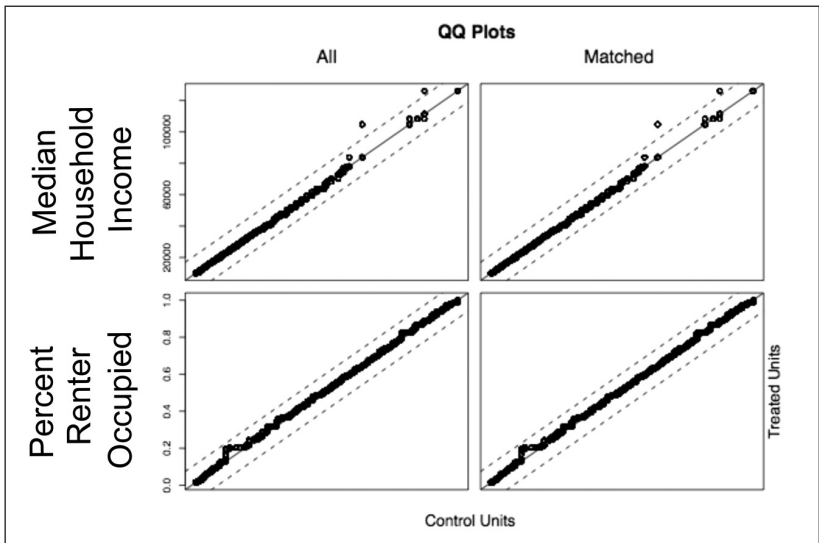
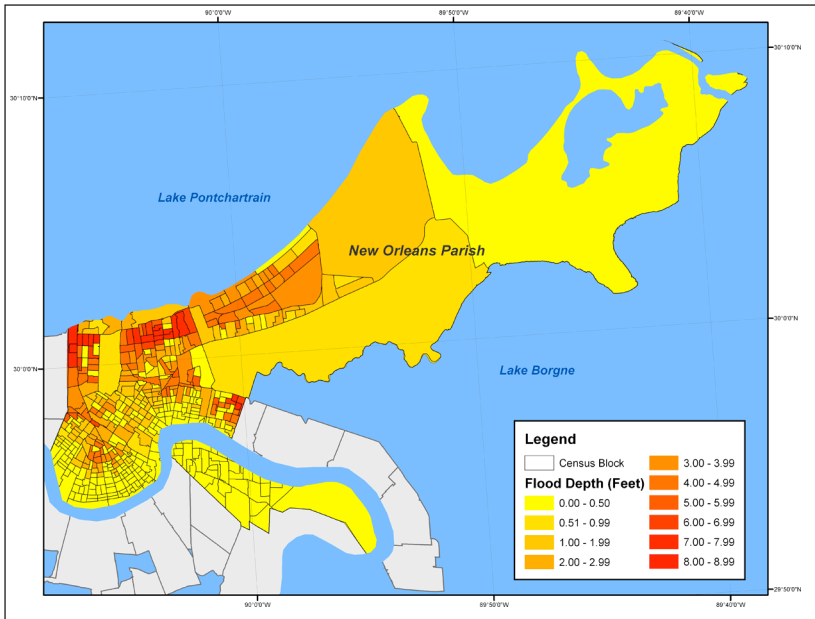


Figure A3. QQ plots, matched versus unmatched sample



**Figure A4.** Flood depth in New Orleans

### Authors' Notes

Previous versions of this research were presented at the 2007 and 2008 Midwest Political Science Association Annual Meetings.

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## Notes

1. Rainfall was ranging from 8 to 12 in (Knabb, Rhome, & Brown, 2005, p. 10). Knabb et al. (2005) of the National Hurricane Center, wrote that “Katrina was on of the most devastating natural disasters in United States history” (p. 1). Further into their report, they note that there were dramatic storm surges in Lake Pontchartrain, for example, surges of 15 to 19 ft in eastern New Orleans and 10 to 14 ft in western New Orleans (p. 9). The flooding was so extensive that recovery efforts in the city and region continue to this day.
2. The Greater New Orleans Community Data Center indicates that according to the U.S. Census Bureau, as of July 1, 2006 there were 210,768 residents in Orleans county compared with 455,046 as of July 1, 2005 (Greater New Orleans Community Data Center, 2008). RAND estimates that in September 2008 (3 years after Hurricane Katrina), the population of New Orleans will only be 56% of its pre-Katrina population—or 272,000 of the original population of 485,000.
3. See the Louisiana Secretary of State’s record of the mayoral primary election, <http://www.sos.louisiana.gov/tabid/1080/Default.aspx>
4. The underlying issue for critics of the 2006 mayoral election, such as the Reverend Jesse Jackson, was the concern that African American voters would not have the skills to navigate the electoral process, especially once they were displaced. As the *Times-Picayune* (Finch, 2006) reported, NAACP Legal Defense Fund attorney Damon Hewitt told [U.S. District Judge Ivan Lemelle] that there are “significant gaps in voter access to the ballot,” including difficulty that many displaced voters would have getting back to the city to vote and recent changes in the location of numerous polling sites in the city. “No one remedy alone is sufficient to cure these violations,” he said. Both Jackson and NAACP officials argued that the absentee ballot process was very confusing and that there were not enough remote voting sites outside of New Orleans (Thevenot, 2006a).
5. See Stein and Vonnahme (2008) for a review of voter turnout and convenience voting.
6. Aldrich and Crook (2008) find that 2004 neighborhood turnout negatively predicts the location of trailer sitings, that is, a documented link between government response and turnout. In footnote 1, they suggest even that “local elections, such as those for mayoral races, would better capture levels of social capital.” These results are consistent with Davis and Bali’s (2008), who suggest that these results are consistent with a NIMBY policy but are in discordance with the theory that turnout would be correlated with anticipated government transfer payments (Chen, 2009).
7. ACORN also organized buses from Dallas, Fort Worth, Houston, and San Antonio to New Orleans for the May 20th Election Day (ACORN, 2006). We do recognize that these

- satellite polling locations also posed additional costs of voting, such as those discussed by Dyck and Gimpel (2005).
8. <http://people-press.org/2005/09/12/four-in-ten-question-rebuilding-new-orleans-in-present-location/>
  9. The Reilly Center for Media & Public Affairs (2005).
  10. 41.15% of the White voters with more than 5 ft of flooding cast a ballot compared with 38.18% who had 5 ft or less, and 41.77% of the non-White voters with more than 5 ft of flooding cast a ballot compared with the 37.63% who had 5 ft or less.
  11. These data come from the Louisiana Secretary of State, <http://www.sos.louisiana.gov/Post-ElectionStatisticsStatewide/tabid/759/Default.aspx>
  12. This includes individuals who registered as recently as December 2005. Also note that this variable is distinct from their participation in the past 20 elections—this variable records the specific elections, up to 20, in which the individual has participated. These elections could have occurred decades earlier. If the voter was eligible to participate in fewer than 20 elections, then the denominator is the number of elections for which they were eligible to vote. These elections include local, statewide, and federal elections for which all individuals in the Orleans Parish were eligible. Unfortunately, these records do not include the method by which each individual voter cast a ballot (absentee, early, in-person, etc.). In the May election, nearly 25,000 individuals took advantage of the opportunity to cast absentee or early ballots, with Nagin winning 12,512 absentee votes compared with Landrieu's 12,336 absentee votes (Coleman & Fischer, 2006).
  13. The mayoral election was postponed in December 2005 by order of Louisiana Governor Kathleen Blanco. Originally scheduled to be held in February 2006, the Governor indefinitely postponed the election based on the recommendations of Secretary of State Al Ater and state elections commissioner Angie LaPlace. Ater noted that many of the city's polling places were completely destroyed and much of the city's voting equipment had been devastated as well (Associated Press, 2005). An election date of April 22 was eventually set for the municipal primary election in New Orleans (Associated Press, 2006b).
  14. We dropped 1,173 individuals who are missing age information in the registration file and 4 individuals who had no registration date from all analyses. The remaining individuals are excluded as we were unable to match their listed address to an address recognizable on a USGS map.
  15. In the appendix Figure A4, we display the depth of the flooding for all of New Orleans by Census Block, where darker colors indicate increased flood depth. We tabulate the number of registered voter households who are affected by each category of water depth in appendix Table A2.
  16. It is important to keep in mind that our population is registered voters, not the potentially larger population of New Orleans residents. We might anticipate a different racial distribution of flood depth given the existing analysis of aggregate data on race, residents, and susceptibility to flooding (Ueland & Warf, 2006). Our data indicate that non-White registered

voters were not more susceptible to high flood depths than non-Whites as seen in appendix Table A3. The proportion of non-White voters who experienced each level of flooding ranges from 65% to 67% and follows no systematic pattern. Non-White registered voters were slightly more likely to experience any flooding (62.94%) than White registered voters (61.71%), although this difference is not statistically significant.

17. The methodological literature on the basic ecological inference problem is well summarized in Achen and Shively (1995) and King (1997).
18. According to an Associated Press (2006c) story “Katrina Evacuees Cast Early Votes in New Orleans Mayoral Race,” as of Monday, April 10, 2006, of the city’s primary mayoral election, “Fewer than half New Orleans’ residents have been able to return to their devastated neighborhoods. New Orleans had nearly a half-million people, about 70 percent of them black, before Hurricane Katrina. Those who have returned number fewer than 200,000 and most are white.”
19. We also consider a model where we take the log of the flood-depth variable with the concern that, given the distribution of depth seen in appendix Table A2, we might anticipate this distribution would not have a normal relationship with the voting outcomes. A reasonable transformation is then to take the log of the flood-depth variable; however, given the presence of zeros, this is not directly possible. We first transform the flood depth (which ranges from 0 to 9) into a variable which is extremely similar, so that  $\text{flood} = .995 \times \text{flood depth} + .005$ . We then take the log of this new flood variable. The coefficient from this model is similar in magnitude and statistical significance; thus, we continue to simply use the absolute depth for ease of interpretation in our analyses.
20. Inclusion of a squared-age term is also effectively zero and is not statistically significant.
21. Flooding did not primarily occur in neighborhoods with high voting propensities, and the propensity to vote variable captures a large amount of the variance associated with the other characteristics that tend to predict turnout (e.g., socioeconomic status). Leaving this variable out of the model results in a large, negative, and statistically significant coefficient estimate for race, for example. The coefficients produced from this model are fairly consistent with those we would anticipate from the literature on turnout. Coefficients from a model estimated when excluding the propensity to vote variable are available from the authors.
22. In other analysis, not reported here, the results in Table 2 are robust to ward fixed effects. These results are available from the authors on request. In appendix Table A2, we document the extent of more than 5 ft of flooding by zipcode. We discern no clear patterns.
23. Both columns of results are robust to the inclusion of ward fixed effects. These results are available from the authors.
24. Inclusion of the interaction of flood depth with number of rental units and household median income, respectively, yields no statistically significant coefficients. These results are available from the authors. In addition, if we exclude the blockgroup variables (as we know there may be biases introduced by using aggregate variables), we find results that are extremely similar.



25. The exact values are .039, standard error .002 and .072, standard error .004, respectively. Both 95% confidence intervals are bounded away from zero.
26. Our goodness-of-fit measures are also not very large; for both columns of Table 2, the psuedo- $R^2$  is approximately .21. This does not concern us, however, as we are including only those variables which are most closely linked to our theoretical model and not those which will explain the greatest variance.
27. We base our analysis on flood depths from 0 to 9 ft. Our data include only 43 individuals who experienced water depths of 10 ft or more; they will be excluded from all further analysis.
28. For a review of the matching literature refer to Ho, Imai, King, and Stuart (2007), and for a review of this particular procedure, see Imai and van Dyk (2004). Note that the authors also ensured that their results were consistent across matching methods; these include genetic matching, optimal matching, and nearest neighbor matching (Diamond & Sekhon, 2005). These results are available from the authors on request.
29. A quantile–quantile plot is used to see whether two data sets come from populations with the same distribution; it plots the quantiles of the first data set against the second. If the two sets come from a population with the same distribution, all the points should fall approximately along the 45° line. In our matched data, we observe that the quantiles between treatment and control are extremely similar. An alternative would be to plot the quantile–quantile plot of the propensity scores, but we present our data this way to provide readers with full information about each covariate, consistent with Imai et al. (2008).
30. Percentage improvement is measured as  $\frac{|a| - |b|}{|a|}$  where  $a$  is the balance before and  $b$  is the balance after matching.
31. Another way to compare the matched and unmatched samples to understand the quality of the match is to evaluate the quantile–quantile plots. Here, we present only one set of such plots in the appendix Figures A1 through A3, the remainder of which are available from the authors. In these figures, there is little visible improvement to the data set (these observations compare the flooding at 0 ft with the flooding at 1 ft). However, in both cases, the balance is fairly close—most of the observations surround the 45° line—and given that this is the case, we have confidence in these estimates.
32. These results are not attributable to unequal effects of flooding impact. FEMA declared any area with 6 in to 1 ft of flooding minor damage and any area with 1 to 2 ft (and above) major damage. Our effect is not discontinuous at 1 ft of water depth and, in addition, FEMA has since issued recommendations that all housing units be at least 3 ft above ground to qualify for flood insurance due to the catastrophic damage typical at 3 ft of flooding (Thevenot, 2006c). FEMA reports on the reimbursement for damages, that “because FEMA only provides reimbursement at three levels, less than \$5,200, \$5,200, and \$10,500,” corresponding to categories based on water depths of 6 in to 1 ft, 1 to 2 ft, or greater (FEMA, 2006).
33. The legislature created 10 remote polling places outside the city of New Orleans, within the state of Louisiana, but rejected the idea of remote polling locations outside the State (Associated

Press, 2006a). Many other procedures were developed to incorporate displaced voters into the electorate ("Absentee Voters," 2006; Filosa & Nolan, 2006; Thevenot, 2006b, 2006d).

34. The initial impact of flooding from Hurricane Katrina did not affect particular socioeconomic groups. As stated in Masozera, Bailey, and Kerchner (2007), "The analyses show that Hurricane Katrina caused severe flood damages in the majority of New Orleans neighborhoods, regardless of income, elevation and other social factors" (p. 303). The percentage improvement after matching is included in Table A4.

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